U.S. Forest Service

# RESEARCH NOTE

CENTRAL STATES FOREST EXPERIMENT STATION
COLUMBUS, OHIO — R. D. LANE, DIRECTOR



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## A RIGID-FRAME PICNIC SHELTER FROM HARDWOOD LUMBER

Increasing demands for outdoor recreation facilities mean that, along with other developments, more picnic areas must be built. One facility usually desired in a picnic area is a shelter. At our Wood Products Pilot Plant we have designed a shelter that is attractive, sturdy, and easily maintained (fig. 1). Designed especially to be constructed from native hardwood lumber, which may be readily available in the central states area, and from other materials that can be obtained in any lumberyard, the parts for this shelter can be fabricated either in a woodworking shop or on the site where it is to be erected.

We used adaptations of the rigid-frame construction system instead of a truss system in our structure. In the latest rigid-frame design, the studs and rafters are joined with nail-glued plywood gussets to form an arch.[1/] This system is simple, inexpensive, and provides clear spans.

A unique feature of our 20- by 30-foot shelter is that we used the rigid-frame design throughout the length of the building as well as across it, thereby eliminating the need for sidewall bracing. For the roof support we used four rigid, stud-rafter frames spaced 10 feet on center. For the eave beam and remainder of the column we also used the rigid-frame system. The 34-foot-long eave beams were made by joining together

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1/ Douglas Fir Plywood Association. Plywood rigid frame design manual. 72 pp., illus. 1962.

Curtis, J. O. Design of nailed and glued plywood gussets for lumber rigid frames. Ill. Agr. Expt. Sta. Bul. 654, 20 pp., illus. 1960.

Curtis, J. O., and Hansen, E. L. Lumber rigid frames for farm buildings. Ill. Col. Agr. Cir. 812, 11 pp., illus. 1959.

FIGURE 1.--A picnic shelter made of hardwood lumber.

two 12-foot pieces and one 10-foot piece. The columns were 6 feet 9 inches high, and when assembled with the stud-rafter units they formed a "T"-shaped member. Conventional ridge board and common rafter assemblies, with rafters spaced 2 feet on center, were used in each 10-foot bay. Sheathing and shingles completed the roof. The stud-rafter frames span 16 feet and a cantilever extension of the rafters provides a roof overhang of 2 feet. Thus, the usable clear area within the shelter is 16 by 30 feet (480 square feet) while the overall roofed area is 20 by 34 feet (680 square feet).

## How to Make the Parts for the Shelter

The shelter requires approximately 800 board feet of nominal 2-inch-thick, No. 1 Common, oak or hickory lumber for structural members; 1,000 board feet of nominal 1-inch-thick, No. 3A Common hardwood lumber such as gum, cottonwood, or soft maple for roof sheathing; and 80 square feet of 3/4-inch-thick exterior type Douglas-fir plywood for gussets. All the lumber should be air-dried to about 20 percent moisture content. We recommend that the shelter parts be made in a shop because a planer, ripsaw, and radial-arm saw are needed to produce parts from rough lumber, and a bandsaw is desirable for cutting gusset notches.

First, crosscut the 2-inch stock to desired rough lengths, eliminating objectionable defects. Next plane the parts on two

sides to a thickness of 1 5/8 inches. Then rip the material on both edges to reduce it to standard widths (i.e. 4-inch stock is ripped to 3 5/8 inches wide, 6-inch stock to 5 1/2 inches, and 8-inch stock to 7 1/2 inches). Finally, make the necessary trim, angle, and the rafter notching cuts with a radial-arm saw.

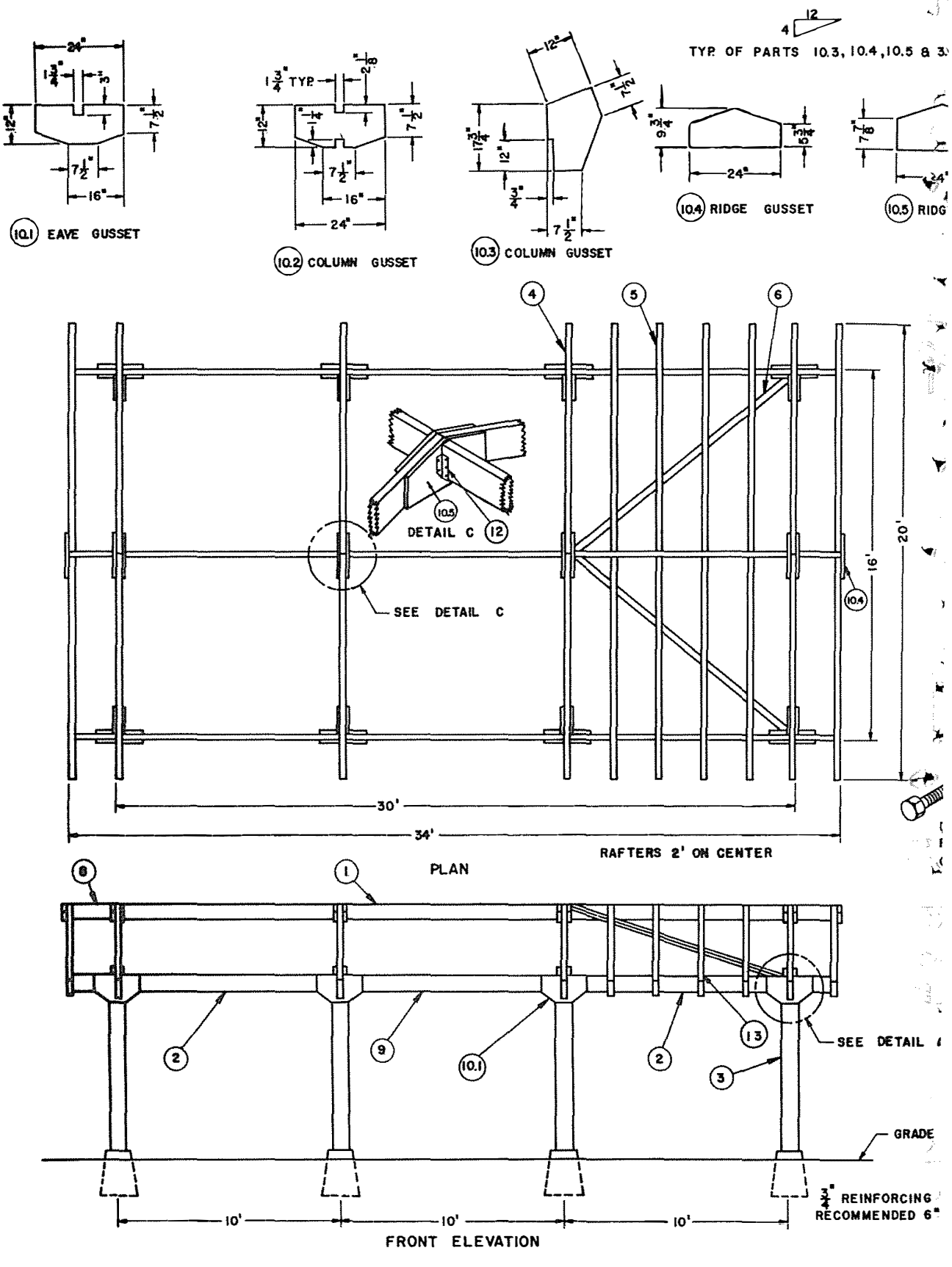
No. 1 Common lumber is usually free of defects that would be objectionable in the structural members. However, precautions must be taken so that knots or other defects do not appear on the edges of the rigid-frame columns, beams, and rafters, especially within 2 feet of the gusset-assembly points.

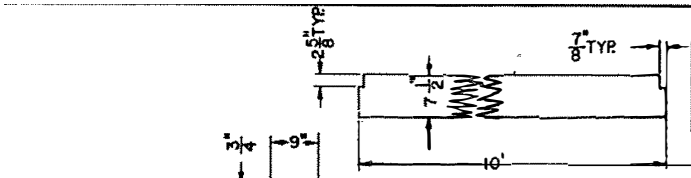
Plane the 1-inch lumber for the roof sheathing on one side to either 3/4 or 7/8 inch in thickness (whichever is preferred) and rip the two edges to a finished width. It is recommended that the hardwood roof sheathing be finished 5 1/2 inches wide, but other widths are satisfactory up to 8 inches. Only one width should be used on a shelter. We found that sheathing can be installed faster if the boards are double-end trimmed in multiples of 2 feet.

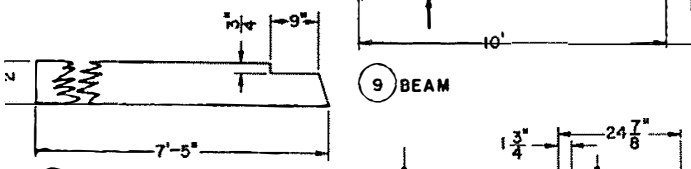
In assembling rigid frames you can save on nailing time by marking the nailing pattern on the gussets with a hardboard template. When it is possible to transport rigid frames from the shop to the site they should be assembled in the shop where gluing conditions can be controlled. Either half-frames or full-frames can be assembled. A pickup truck can easily haul half-frames of the stud-rafter type and up to 12-foot-long sections of the column-eave-beam type.

To assemble the stud-rafter units, lay out one set of parts on the floor or on a jig table and align them for the roof pitch and span. Next, mark the floor, or set stop blocks on the jig table, so that subsequent sets of frame parts will be properly located. Spread glue on the gussets and on the framing members at the gusset locations. Nail the gussets in place with 6d common nails according to the nailing schedule shown in the working drawing. No clamping is necessary since the nails provide sufficient gluing pressure. Turn the assembly over and apply glue and gussets to the other face of the joints. Allow 24 hours for the glue to cure. If only half-frames are being assembled, do not attach the ridge gusset in the shop.

Assemble the sections of the column-eave-beam units in the same way the stud-rafter units were assembled. The gusset and beam notches must be aligned to accept the rafters and the col-

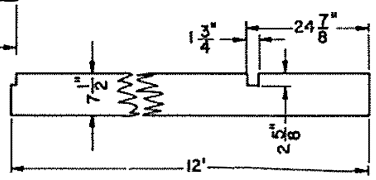

4 12
TYP. OF PARTS 10.3, 10.4, 10.5 & 3
24"
1¾"
3"
12"
7½"
16"
10.1 EAVE GUSSET
1¾" TYP.
2⅛"
1¼"
24"
10.2 COLUMN GUSSET
12"
7½"
17¾"
12"
4¾"
10.3 COLUMN GUSSET
9¾"
5¾"
10.4 RIDGE GUSSET
7⅞"
10.5 RIDG
4
5
6
DETAIL C
10.5
12
SEE DETAIL C
16'
20'
10.4
30'
34'
RAFTERS 2' ON CENTER
PLAN
8
1
2
9
10.1
2
13
3
SEE DETAIL
GRADE
¾" REINFORCING
RECOMMENDED 6"
10'
10'
10'
FRONT ELEVATION



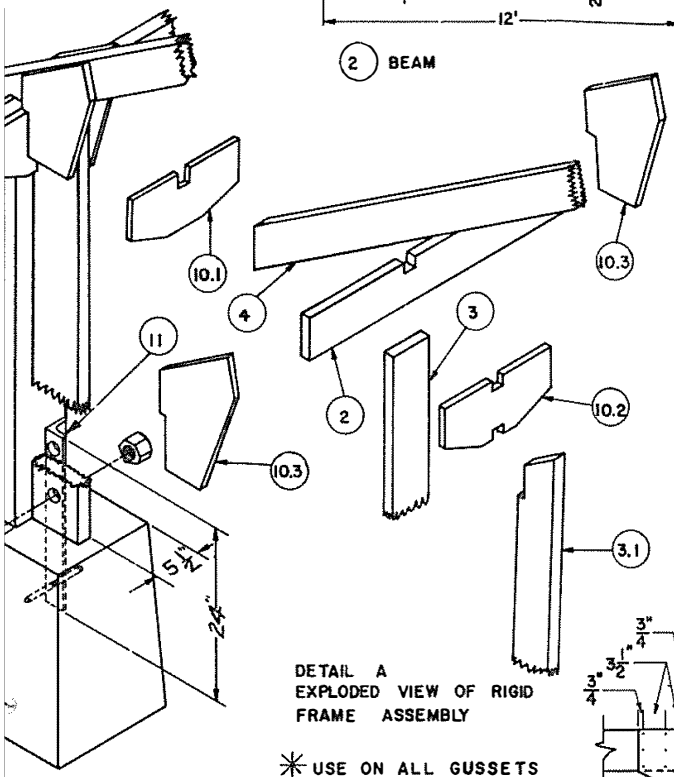




(9) BEAM

(3.1) COLUMN




(2) BEAM

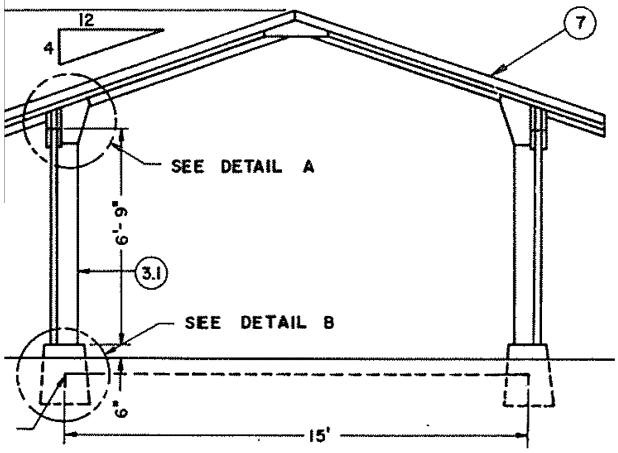



DETAIL A
EXPLODED VIEW OF RIGID FRAME ASSEMBLY

✳ USE ON ALL GUSSETS

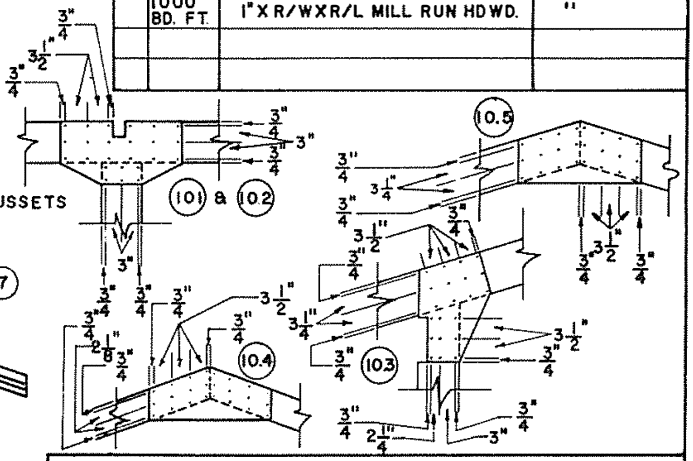
NAILING PATTERN FOR GUSSETS IS SHOWN AT RIGHT

BOLTS IN EACH SIDE MINIMUM SPACING




END ELEVATION

| NO. | REQD. | DESCRIPTION | PART NAME |
|---|---|---|---|
| 1 | 3 | 2"X8"X10' I COM OAK | RIDGE |
| 2 | 4 | 2"X8"X12' I " " | BEAM |
| 3 | 8 | 2"X8"X 8' I " " | COLUMN |
| 3.1 | 8 | 2"X8"X 8' I " | COLUMN |
| 4 | 8 | 2"X8"X 12' I " " | RIGID RAFTER |
| 5 | 28 | 2"X6"X 12' I " " | INTER RAFTER |
| 6 | 4 | 2"X4"X 14' I " " | WIND BRACE |
| 7 | 4 | 1" X2"X 12' I " " | TRIM |
| 8 | 2 | 2"X8"X 22 1/2" I " " | END RIDGE |
| 9 | 2 | 2"X8"X 10' I " " | BEAM |
| | 2.5 | 3/4"X4' X8' AC FIR PLYWOOD | ✳ |
| 10.1 | 8 | 3/4"X12"X24" | EAVE GUSSET |
| 10.2 | 8 | 3/4"X 12"X24" | COLUMN " |
| 10.3 | 8 | 3/4"X 13 3/4"X 21 5/8" | COLUMN " |
| 10.4 | 2 | 3/4"X 9 3/4"X24" | RIDGE " |
| 10.5 | 8 | 3/4"X 11 7/8"X24' | RIDGE " |
| 11 | 8 | 3"X3"X 2" STEEL ANGLE | PURCHASE |
| 12 | 8 | 2"X8" GALV. JOIST HANG. | " |
| 13 | 100 | GALV. FRAMING ANCHORS | " |
| | | | |
| | | | |
| | 850 SQ. FT. | SHINGLES OR ROLL ROOFING | PURCHASE |
| | 4 LBS | CASEIN GLUE | " |
| | 20 LBS | 1" GALV ROOFING NAILS | " |
| | 40 LBS. | 8d COMMON NAILS | " |
| | 32 | 3/4"-10 UNC X 3" HEX. HD. BOLTS | " |
| | 32 | 3/4"-10 UNC X 3" HEX. NUTS | " |
| | 32 | 3/4"X 1 1/2" WASHERS | " |
| | 1 1/2 YDS. | 2:3:5 MIX CONCRETE | " |
| | 10 LBS. | 6d COMMON NAILS | " |
| | 1000 BD. FT. | 1"X R/WXR/L MILL RUN HDWD. | " |
| | | | |
| | | | |




# RIGID FRAME PICNIC SHELTER

DEVELOPED BY THE

WOOD PRODUCTS PILOT PLANT, CENTRAL STATES FOREST EXPERIMENT STATION, U. S. FOREST SERVICE IN COOPERATION WITH VOCATIONAL TECHNICAL INSTITUTE OF SOUTHERN ILLINOIS UNIVERSITY

| 1-6-1964 | DESIGNED BY: W.W. RICE | DRAWN BY: J. GASPER |
|---|---|---|

umns must be at right angles to the beams when the gussets are installed. If these assemblies cannot be transported as 34-foot-long units, assemble only the 12-foot-long end-bay sections in the shop. If this is done, the 10-foot-long center-eave beam for each side of the shelter must be nail-glued in the field.

A wood preservative should be applied to the base of each stud and column before assembly to protect them from insect and decay damage. An effective method is to stand the studs and columns in drums or tubs of a 5 percent solution of pentachlorophenol in mineral spirits for 24 hours. The base of each member needs protection to 1 foot above the concrete line.

## Laying the Foundation

The site for the shelter should be clear of brush and reasonably level. The foundation may be either a concrete slab or individual concrete piers for the columns. Steel reinforcing should be used in the concrete slab and the footings should extend below the frostline. If piers are used, they should be about 13 by 16 inches at ground surface and flair out to about 16 by 19 inches at the bottom which should be below frostline. Set the steel angle used to anchor the columns to the floor or pier when the concrete is poured. Be sure to space the steel angles so they can be bolted to the pre-assembled wood members.

## Erecting the Shelter

Position the four stud-rafter units and bolt them to the steel angles. Temporary bracing should be used as needed to hold these units in place. If the rigid frame members are nail-glued at the site instead of in a shop, they should not be erected for 24 hours so the glue will have time to cure.

Install the three ridge boards using metal joist hangers; then put the column-eave-beam units in place. Either nail or screw the column to the stud using 20d spikes or 3/8- by 5-inch lag screws.

If the column-eave-beam units were not fully assembled in the shop, set the side beams for the center bay and nail-glue them in place.

Install the intermediate rafters. Metal framing anchors are recommended for fastening the rafters to the ridge board

and eave beam because they are easy to install and have good holding power.

Assemble the end rafter and end ridge board on the ground, raise into place, and fasten with framing anchors.

Cut and install the 2- by 4-inch wind-bracing members. These should be spiked to the under side of each rafter as well as to the rigid frames at the ends.

Install the roof sheathing and shingles. For a more rustic appearance, install the sheathing with the rough side down. Trim boards may be used as desired at the eaves and on the end gables.

The entire structure may be brush or spray finished with a durable outdoor stain. The Forest Products Laboratory natural finish with double-strength pigments is suitable for this purpose and is easy to apply and maintain.[2/]

The length of the shelter can be extended indefinitely by adding bays as long as 10 feet each. But the roof will not safely span more than a 20-foot width unless rafters and columns are strengthened.

An attractive variation is to add a raked roof overhang at the ends of the shelter. This can be done by installing a 5-foot-long end ridge board, one pair of common rafters beyond the end rigid frame, and a pair of 10-foot, 11 1/4-inch end rafters. The longer end rafters are joined to the other rafters by bolts. Angle iron, 2 inches by 2 inches by 5 inches long, and bolts connect the end rafters to the ridge. To prevent sag in the raked overhang, place solid 2- by 6-inch bridging between the rafters. The bridging terminates at the outside of the end rigid frame.

## Costs

We built shelters of this design in 280 to 300 man-hours, depending on whether parts were cut and assembled in the shop or at the building site. We used semi-skilled labor, however, and so believe the job could be done in less than 200 hours using skilled labor at both shop and site. Further savings in

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2/ U.S. Forest Products Laboratory. Forest Products Laboratory natural finish. FPL Rpt. No. 2096, 4 pp. 1961.

labor are possible if surfaced dimension stock and roof sheathing are used. Of course, savings here will be reflected in higher material costs.

We estimate that our shelter can be built for as little as $1,000, allowing $350 for materials (table 1) and $650 for labor. We assume that shelter parts are prefabricated in a well-equipped shop and erected by skilled workers. These costs do not include machine operation, overhead, and profit.

TABLE 1.--Material cost for a 20- by 34-foot hardwood picnic shelter[1/]

| Item | Amount | Unit Cost | Total Cost |
|---|---|---|---|
| | | | Dollars |
| 8/4 Framing lumber | 800 bd. ft. | $115/MBF | 92.00 |
| 4/4 Sheathing lumber | 1,000 bd. ft. | $55/MBF | 55.00 |
| 3/4 Plywood | 80 sq. ft. | 22¢/sq. ft. | 17.60 |
| Asphalt shingles | 7 2/3 squares | $9/square | 69.00 |
| Framing anchors | 100 | $15/C | 15.00 |
| Roofing nails | 20 lbs. | 16¢/lb. | 3.20 |
| Common nails | 40 lbs. | 15¢/lb. | 6.00 |
| Concrete | 1 1/2 yds. | $16/yd. | 24.00 |
| Glue | 4 lbs. | 40¢/lb. | 1.60 |
| Bolts, steel parts | -- | -- | 20.00 |
| Wood preservative | 20 gal. | 70¢/gal. | 14.00 |
| Stain | 5 gal. | $6/gal. | 30.00 |
| Total | | | $347.40 |

1/ Based on prices in Carbondale, Illinois, August 1964.

William W. Rice, superintendent
Wood Products Pilot Plant
Carbondale, Illinois
(Maintained in cooperation with
Southern Illinois University)